

Strength, Weakness, Opportunity, Threat (SWOT) analysis of the adaptations to anatomical education in the United Kingdom and Republic of Ireland in response to the Covid-19 pandemic

Article (Published Version)

Longhurst, Georga J, Stone, Danya M, Duloher, Kate, Scully, Deirdre, Campbell, Thomas and Smith, Claire F (2020) Strength, Weakness, Opportunity, Threat (SWOT) analysis of the adaptations to anatomical education in the United Kingdom and Republic of Ireland in response to the Covid-19 pandemic. Anatomical Sciences Education. ISSN 1935-9772

This version is available from Sussex Research Online: <http://sro.sussex.ac.uk/id/eprint/91206/>

This document is made available in accordance with publisher policies and may differ from the published version or from the version of record. If you wish to cite this item you are advised to consult the publisher's version. Please see the URL above for details on accessing the published version.

Copyright and reuse:

Sussex Research Online is a digital repository of the research output of the University.

Copyright and all moral rights to the version of the paper presented here belong to the individual author(s) and/or other copyright owners. To the extent reasonable and practicable, the material made available in SRO has been checked for eligibility before being made available.

Copies of full text items generally can be reproduced, displayed or performed and given to third parties in any format or medium for personal research or study, educational, or not-for-profit purposes without prior permission or charge, provided that the authors, title and full bibliographic details are credited, a hyperlink and/or URL is given for the original metadata page and the content is not changed in any way.

Strength, Weakness, Opportunity, Threat (SWOT) Analysis of the Adaptations to Anatomical Education in the United Kingdom and Republic of Ireland in Response to the Covid-19 Pandemic

Georga J. Longhurst,¹ Danya M. Stone,^{2*} Kate Duloher,³ Deirdre Scully,⁴ Thomas Campbell,⁵ Claire F. Smith²

¹Department of Anatomical Sciences, St. George's, University of London, London, United Kingdom

²Department of Medical Education, Brighton and Sussex Medical School, University of Sussex, Falmer, United Kingdom

³School of Medical Education, Newcastle University, Newcastle upon Tyne, United Kingdom

⁴Department of Anatomy, School of Medicine, Trinity College Dublin, The University of Dublin, Dublin, Republic of Ireland

⁵School of Medicine, University College Dublin, Dublin, Republic of Ireland

The Covid-19 pandemic has driven the fastest changes to higher education across the globe, necessitated by social distancing measures preventing face-to-face teaching. This has led to an almost immediate switch to distance learning by higher education institutions. Anatomy faces some unique challenges. Intrinsically, anatomy is a three-dimensional subject that requires a sound understanding of the relationships between structures, often achieved by the study of human cadaveric material, models, and virtual resources. This study sought to identify the approaches taken in the United Kingdom and Republic of Ireland to deliver anatomical education through online means. Data were collected from 14 different universities in the United Kingdom and Republic of Ireland and compared adopting a thematic analysis approach. Once themes were generated, they were collectively brought together using a strength, weakness, opportunity, threat (SWOT) analysis. Key themes included the opportunity to develop new online resources and the chance to engage in new academic collaborations. Academics frequently mentioned the challenge that time constraints could place on the quality and effectiveness of these resources; especially as in many cases the aim of these resources was to compensate for a lack of exposure to cadaveric exposure. Comparisons of the actions taken by multiple higher education institutions reveal the ways that academics have tried to balance this demand. Discussions will facilitate decisions being made by higher education institutions regarding adapting the curriculum and assessment methods in anatomy. *Anat Sci Educ* 0: 1–11. © 2020 The Authors. Anatomical Sciences Education published by Wiley Periodicals LLC on behalf of American Association for Anatomy.

Key words: Gross anatomy education; undergraduate education; medical education; distance learning; Covid-19; anatomy; pedagogy; assessment; online education

*Correspondence to: Ms. Danya M. Stone, Brighton and Sussex Medical School, University of Sussex, Medical School Building, Falmer, BN1 9PX, United Kingdom. E-mail: D.Stone@bsms.ac.uk

Additional supporting information can be viewed in the online version of this article.

Received 10 April 2020; Accepted 13 April 2020.

Published online ## ## in Wiley Online Library (wileyonlinelibrary.com). DOI 10.1002/ase.1967

© 2020 The Authors. Anatomical Sciences Education published by Wiley Periodicals LLC on behalf of American Association for Anatomy

This is an open access article under the terms of the Creative Commons Attribution-NonCommercial License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited and is not used for commercial purposes.

INTRODUCTION

The coronavirus (Covid-19) pandemic is an unprecedented emergency that has affected all global industries, including education (Ayittey et al., 2020). With the widespread implementation of social distancing and self-isolation policies, it is not feasible for educators and students to attend lessons or assessments as they have previously. The Covid-19 pandemic has disrupted our long-standing educational practices and has precipitated an urgent need for many institutions to rapidly implement alternative educational and assessment strategies.

Covid-19 Timeline

On 31st December 2019, the World Health Organization (WHO) was informed of a small cluster of pneumonia cases with unknown etiology in the Wuhan city, Hubei province, China (WHO, 2020a; Zhu et al., 2020). The novel coronavirus was isolated on 7th January 2020 and genetically sequenced on 12th January (WHO, 2020a; Wong et al., 2020). The virus was confirmed to have subsequently spread to Thailand, Japan, and the Republic of Korea, on 13th, 15th and 20th January, respectively (WHO, 2020a). On January 23rd 2020, the government of China imposed a modern form of quarantine, shutting down all transportation in and out of Wuhan. The lockdown expanded to twelve other cities in the Hubei province (Rubin and Wessely, 2020). Covid-19 was first confirmed in the United Kingdom (UK) and Republic of Ireland (ROI) on 29th January 2020 and 29th February 2020, respectively (Holmes, 2020; HPSC, 2020). On 11th March 2020, the WHO officially declared the outbreak a pandemic (WHO, 2020b). To control the outbreak of the virus, Public Health England (PHE, 2020) and the Department of Health and Department of the Taoiseach in the ROI (DH&DT, 2020) introduced increasingly restrictive policies governing the movement and gathering of people. Social distancing was implemented in the UK on 17th March 2020 (Mahase, 2020) and even greater restrictions to movement were implemented on 23rd March 2020 (PHE, 2020).

Lessons Learned by Medical Educators During the SARS Epidemic

Historic pandemics, such as the severe acute respiratory syndrome (SARS) also saw changes to educational practices and important lessons were learned. During the SARS epidemic, Chinese and Canadian medical schools were forced to cease their clinical clerkships and electives (Ahmed et al., 2020). Chinese medical schools supplemented their students learning experiences with the introduction of online problem-based learning (Ahmed et al., 2020). At the same time in Hong Kong, university policies decreed that the external examiner must be present for final-year medical distinction examinations (Patil and Yan, 2003). These examinations traditionally took place as viva voce examinations; however, because the external examiner could not be present, these examinations took place by phone call. Due to concern regarding the stability of the phone connection, the first part of the examination was conducted by an external examiner and no interruptions were reported (Patil and Yan, 2003). These solutions could similarly be utilized by anatomists in addressing the challenges that have arisen due to the Covid-19 pandemic.

Context for Universities

Education institutes across all levels (pre-primary, primary, secondary and tertiary) have closed in 188 countries across the globe,

impacting over 91% of the world's student population (UNESCO, 2020). Universities in the UK started to close from the 16th of March. Universities in the ROI were formally closed on 12th March 2020 (RTÉ, 2020) and face-to-face teaching was suspended from 16th March, following government advice. Universities have moved all teaching activities online and set up communication platforms, such as webpages and email streams to inform students of the ever-changing circumstance. The majority of higher education institutions in the UK and ROI begin their academic term in August or September, and this cessation of face-to-face teaching occurred during the second or third semesters. Educators were forced to rapidly find solutions to many challenges; for some this meant moving to online delivery within days. Governmental education departments released guidance for students and educators in response to this (DES, 2020; GOV.UK, 2020a, b).

Context of Medical Education

There are over 45,000 medical students in the UK and ROI (GMC, 2017; Heffron and Socha-Dietrich, 2019). Approximately half of these students are completing formal anatomical education during the early years of their program (Heylings, 2002). Therefore, alternative educational and assessment strategies will impact a large cohort of approximately 20,000 students with immediate effect. For final years, the General Medical Council (GMC) urged medical schools to fast track the graduation and registrations of these students to supplement the healthcare workforce (MSC, 2020). The Google Hangouts (Google Meet) video conferencing application (Google Inc., Mountain View, CA) has successfully been used to deliver lessons to medical students assigned to surgical specialties and it has been speculated that these could similarly be implemented to supplement anatomical education (Moszkowicz et al., 2020). At Imperial College London, teleteaching and telemedicine modalities have been implemented to supplement the clinical needs of final-year medical students, and these students are currently perfecting their clinical judgment using an online repository of patient interviews and clinical cases (Mian and Khan, 2020). In related fields, such as dentistry, there have also been recommendations to shift education toward online platforms (Meng et al., 2020).

Context of Anatomical Education

There are 41 medical schools in the UK and seven in ROI. Recently, five new medical schools in the UK were created but have not been included in the sample as they are either not currently taking students or are under the umbrella affiliation of another medical school and are hence using their curriculum. The number of hours dedicated to anatomy teaching and the number of anatomical staff members significantly varies throughout the UK. Anatomy is taught through systems-based curricula, problem-based curricula, or in the traditional regional format. Lancaster University Medical School, Peninsula College of Medicine and Dentistry, and University of Limerick Medical School are the only institutions that do not use human cadavers to teach anatomy (Heylings, 2002).

Impact on Quality of Education and Adoption of Alternate Learning Strategies

Educators across the globe have been forced to replace traditional learning modalities with distance and blended learning approaches. Distance learning has been described as an

information delivery mechanism where the educator and learner are separated in both time and space (Billings, 2007), whereas blended learning combines traditional classroom methods of learning with online learning modalities (Green and Whitburn, 2016). Neither approach is novel, and both have been used successfully as part of anatomy education (Pereira et al., 2007; Ferrer-Torregrosa et al., 2016). However, these approaches are usually implemented after strategic planning, collaboration with other academics, and careful consideration of the pedagogical evidence. In order to utilize online approaches, educators must invest considerable time up-front to learn how to create online learning material. In many cases, academics are required to develop these new skills and create or adapt resources in parallel with a time frame that reflects the normal progression of student learning.

Impact on Body Donation Programs

The storage, maintenance, and embalming of cadaveric specimens poses a further challenge to anatomy departments with limited on-site access. With the body donation program largely halted in the UK and ROI (HTA, 2020a), there may be a reduced number of available specimens for teaching in the following academic year. Guidance from the International Committee of the Red Cross (ICRC) has also suggested that medical schools may provide body storage facilities as a contingency for mortuary overflow (Finegan et al., 2020), with updated guidance on licensing of emergency mortuaries concurrently released by the Human Tissue Authority (HTA) to support this (HTA, 2020b). This may result in existing cadaveric material being compromised, placing further strain on availability of specimens going forward.

Impact on Academic Workforce

Due to the unprecedented demand that the Covid-19 pandemic has placed on public health services, clinically trained anatomists have been encouraged to return to the clinical workforce (Willan et al., 2020). In addition, non-clinical academic staff may contract Covid-19, or have caring responsibilities placing additional demands on the remaining members within a team of anatomists, disproportionately affecting universities with smaller academic teams, or in locations where only one anatomist is employed placing considerable burden on them. The negative impact on the mental wellbeing of healthcare workers due to anxieties and pressure in relation to Covid-19 has already been documented (Shaw, 2020).

Aims of the Study and Research Questions

This research aimed to understand the variety of solutions being utilized across institutions in the UK and ROI and to facilitate easier decision-making surrounding changes to curriculum and assessment strategy. The two research questions were: (1) What strategies have been adopted by UK and ROI anatomy departments in response to Covid-19? and (2) What strengths, weaknesses, opportunities, and threats does the instant move to online learning bring?

MATERIALS AND METHODS

The questionnaire was conceptualized by the researchers for this study (G.J.L., D.M.S., K.D., D.S., and T.C.) in order to obtain

information from anatomy departments across the UK and ROI on their institutional and departmental responses to the Covid-19 pandemic. All questions proposed by the researchers were selected for review. Only the questions that were agreed by all contributors were selected. The seven questions that were selected focused around three themes: (1) location of university and size of anatomy team, (2) adaptations to teaching and resources used in lectures and practical sessions and (3) major challenges and opportunities (see Supporting Information 1). All feedback was solicited by way of free-text responses. A pilot study was completed in the respective institutions of the researchers (G.J.L., D.M.S., K.D., D.S., and T.C.), and on review there were no post-pilot modifications made. The questionnaire was tabulated in a Microsoft Word document (Microsoft Corp., Redmond, WA) and emailed to anatomists in higher education institutions in the UK and ROI. The list of anatomists and institutions selected for this study was created using a convenience sample of known contacts. A total of 14 responses were received from the 27 medical schools that were contacted (52% response rate).

The adaptations to lectures, practical, and assessment were collated and summarized and a thematic analysis was carried out on the opportunities and challenges. All responses were analyzed using thematic analysis by the researchers (G.J.L., D.M.S., K.D., D.S., and T.C.) (Glaser and Strauss, 1967; Braun and Clarke, 2012). To achieve this, the six-phase process described by Braun and Clarke (2012) was followed. First, all authors read through the entire data set to familiarize themselves with the data. Initial codes were then manually generated using an open-coding approach by highlighting interesting and relevant aspects of the responses. This was done individually and then any discrepancies discussed in order to minimize bias. Codes were then collated into more general themes. These themes were reviewed by all authors to ensure they fully reflected the responses. Due to the small sample size, themes were generated without digital programs. The most commonly reoccurring themes were then used to inform the next stage of the analysis, as well as other essential themes as identified by the authors. The authors assigned these themes to either strengths, weaknesses, opportunities, or threats for the purpose of SWOT analysis, an analytical approach commonly used to inform strategic planning and decision making (Helms and Nixon, 2010; Teoli and An, 2019). A SWOT analysis was originally developed as a business tool to aid decision making, but has since been used to analyze strategies in higher education, including medical education (Sharma, 2005; Burr, 2009; Liu, 2017; Hazzan et al., 2018; Leiber et al., 2018).

Due to the urgent and rapidly evolving nature of Covid 19, it was not possible to secure ethical approval. To mitigate this, it was made clear that respondents were providing data and by doing so were consenting for the data to be used. The authors are planning a follow-up study from different stakeholders' perspectives and this will go through full ethical approval and the data presented here will be considered as pilot data.

RESULTS

Fourteen universities provided information on the departmental response to Covid-19. Twelve universities were UK based and two were based in the ROI. The results presented here represent 39% and 33% of medical schools in the UK and ROI, respectively. Ten of the UK-based universities are located in England, one is located in Wales and another one in Northern Ireland. The two Irish universities are located in Dublin.

Delivery of Teaching

Lectures. Universities opted to replace lectures with recorded presentations and accompanying audio that was uploaded to the Virtual Learning Environment. The most common lecture recording platform used was “Panopto” (Panopto Inc., Seattle, WA), with 50% of universities citing its use. Thirty-six percent of universities also provided live sessions and tutorials via platforms such as “Zoom” (Zoom Voice Communications Inc., San Jose, CA), “Collaborate Ultra” (Blackboard Inc., New York, NY), and “Big Blue Button” (Big Blue Button Inc., Ottawa, Canada).

Practical sessions. All but two universities in the sample group used cadaveric material to teach anatomy prior to the pandemic. Universities replaced practical sessions by supplementing Virtual Learning Environments with additional resources. Twenty-nine percent of universities used digitized cadaveric resources only, seven percent used 3D virtual resources only, and 43% used a combination of cadaveric and 3D virtual resources (Table 1). Digitized cadaveric resources included “Acland’s Video Atlas of Human Anatomy” (Acland, 2013), high-quality cadaveric images, bespoke videos of prosected/plastinated specimens, YouTubeTM videos (YouTube, San Bruno, CA), and the Visible Human Project (U.S. National Library of Medicine, Bethesda, MD) (Table 2). Three-dimensional virtual resources included “Visible Body” (Argosy Publishing, Inc., Newton, MA), “Complete Anatomy” (3D4Medical/Elsevier, Dublin, Republic of Ireland), 3D models using “Sketchfab” (Sketchfab, New York, NY), “Anatomy TV” (Primal Pictures Ltd., Colchester, UK), and “Sectra” (a virtual dissection table; Sectra AB, Linköping, Sweden) (Table 2). Forty-three percent of universities provided further support for practical sessions by hosting live tutorials and sessions using platforms such as “Zoom” (Zoom Voice Communications Inc., San Jose, CA) and “Microsoft Teams” (Microsoft Corp., Redmond, WA).

Assessment. Fourteen percent of universities did not have a summative practical assessment in their curriculum, a further 36% of universities canceled their assessment and 21% completed online digital spotter examinations (Table 3). Written examinations were canceled in seven percent of universities (Table 3). Thirty-six percent opted for online multiple-choice questions (MCQs)/Extending matching questions (EMQs)/Single-answer questions (SAQs)/Single-best-answer (SBAs) examinations and 21% opted for open-book examinations (Table 3). There were no regional differences noted with regard to assessment.

Opportunities and challenges. Despite chronic disruption to curricula, the Covid-19 pandemic has presented many opportunities to universities. The opportunity to develop new online resources was highlighted by 71% of universities. Fifty percent of universities cited academic collaboration as an important opportunity, and 29% highlighted the importance of working from home. Universities identified other opportunities such as upskilling in new technologies (21%), incorporation of blended learning (14%), development of alternative examination methods (7%), and free access to online resources (7%) (Table 4). The most commonly expressed concern was the time investment associated with the development of new resources to replace lectures and practical classes. This challenge was highlighted by 57% of universities. Fifty percent of universities were concerned about lack of practical sessions/cadaveric exposure, and 36% of universities identified reductions in student engagement. Universities also highlighted concerns regarding the teacher–student relationship (21%),

Table 1.

Summary of Resources Used for the Delivery of Practical Sessions

Resource	Responding universities; n (%)
Digitized cadaveric resource only	4 (28.6)
3D virtual resource only	1 (7.1)
Both cadaveric and 3D virtual resources	6 (42.9)
Not applicable ^a	3 (21.4)

^aNot applicable refers to universities where the question did not apply to them or where incomplete information was provided; 3D, three-dimensional; Total number of respondents ($n = 14$).

assessment (14%), working from home (14%), suspension of Body Donor Programs (7%), and lack of technical support (7%) (Table 4).

Table 2.

List of Digitized Cadaveric and Three-Dimensional (3D) Virtual Resources Used for the Delivery of Practical Sessions

Resource	Responding universities; n (%)
Digitized cadaveric resources	
“Acland’s Video Atlas of Human Anatomy” (Acland, 2013)	5 (35.7)
Cadaveric images	6 (42.9)
Bespoke videos (prosected/plastinated specimen)	3 (21.4)
YouTube videos (YouTube, San Bruno, CA)	2 (14.3)
“Visible Human Project” (U.S. National Library of Medicine, Bethesda, MD)	1 (7.1)
Three-dimensional (3D) virtual resources	
“Visible Body” (Argosy Publishing, Inc., Newton, MA)	1 (7.1)
“Complete Anatomy” (3D4Medical/Elsevier, Dublin, Republic of Ireland)	2 (14.3)
“Anatomy TV” (Primal Pictures Ltd., Colchester, UK)	2 (14.3)
Sketchfab 3D models (Sketchfab, New York, NY)	3 (21.4)
Sectra virtual dissection table (Sectra AB, Linköping, Sweden)	1 (7.1)

Total number of respondents ($n = 14$).

Table 3.

Summary of Current Assessment Strategies for Anatomy

Format of assessment	Responding universities; n (%)
Practical summative assessment	
No pre-existing examination	2 (14.3)
Digital spotter	3 (21.4)
Cancelled	5 (35.7)
Not applicable ^a	4 (28.6)
Written summative assessment	
Online MCQ/EMQ/SAQ/SBA	5 (35.7)
Online open book	3 (21.4)
Cancelled	1 (7.1)
Not applicable ^a	5 (35.7)

^aNot applicable refers to universities where the question did not apply to them or where incomplete information was provided; MCQs, multiple-choice questions; EMQs, extending matching questions; SAQs, single-answer questions; SBA, single best answer. Total number of respondents ($n = 14$).

DISCUSSION

Many universities documented similar pedagogical opportunities and challenges. Themes from the responses to top opportunities and challenges are sorted into a SWOT analysis and used to form the basis of this discussion. Reoccurring strengths included the development of new resources and skills. Time constraints, lack of exposure to cadaveric material, and changes to assessment were identified as weaknesses. Opportunities identified included academic collaboration and working remotely, as well as with the opportunity to implement blended learning in future curriculum development. The reduction in quality of resources, reduced student engagement, and diminished student-teacher relationship were considered threats (Fig. 1). The approaches taken by higher education institutions and the effect these have on the strengths, weaknesses, opportunities, and threats currently faced are also discussed to elicit which approaches could prove most effective.

Strengths

Development of new online resources. In response to the Covid-19 lockdown, both digitized cadaveric resources and 3D virtual anatomy platforms were used by 43% of universities, in an attempt to emulate canceled practical sessions. Twenty one percent of universities created unique videos. Bespoke resources have been shown to lead to a significant increase in student satisfaction (Mandernach, 2009). New resources created and developed by academics include videos, virtual dissections, formative quizzes, and updating practical dissection notes that will be available to students through Virtual Learning Environments. Previous studies have elucidated that students

Table 4.

Opportunities and Challenges to Anatomical Education in the Face of Covid-19

Delivery of teaching	Responding universities; n (%)
Opportunities	
Development of new online resources	10 (71.4)
Academic collaboration	7 (50.0)
Working remotely	4 (28.6)
Upskilling in new technologies and resources	3 (21.4)
Incorporation of blended learning in future curriculum development	2 (14.3)
Free access to online resources	1 (7.1)
Development of alternative examination methods	1 (7.1)
Challenges	
Time constraints	8 (57.1)
Lack of practical sessions and cadaveric exposure	7 (50.0)
Reduced student engagement	5 (35.7)
Teacher/student relationship	3 (21.4)
Issues with assessment	2 (14.3)
Working from home under current Covid-19 lockdown	2 (14.3)
Suspension of Body Donor Program	1 (7.1)
Lack of technical support within institution	1 (7.1)
Reduction in quality of resources	1 (7.1)

Total number of respondents ($n = 14$).

appreciate anatomical videos and they have the potential to improve test scores (Pereira et al., 2004; DiLullo et al., 2006; Topping, 2014). To date, there are limited data on the effectiveness of virtual dissections; however, the results have been positive, when used in conjunction with cadaveric material (Yammine and Violato, 2015; Darras et al., 2019). A significant number of medical students have reported that they find online resources helpful (Smith et al., 2014). This echoes a statement by one academic who stated gaining “free access to high quality resources from publishers” was a positive aspect of the pandemic. Interestingly, the usefulness of online resources for individual students has been linked to personality preference, and thus the switch to distant learning may prove harder for certain groups of students (McNulty et al., 2006).

The context of the anatomical learning environment has undergone a paradigm shift since the lockdown, and this may

S Organizational STRENGTHS		W Organizational WEAKNESSES		O Environmental OPPORTUNITIES		T Environmental THREATS	
• Development of new online resources	71%, n=10	• Time constraints	57%, n=8	• Academic collaboration	50%, n=7	• Reduced student engagement	36%, n=5
• Upskilling in new technologies and resources	21%, n=3	• Lack of practical sessions and cadaveric exposure	50%, n=7	• Working remotely	29%, n=4	• Diminished teacher / student relationship	21%, n=3
		• Issues with assessment	14%, n=2	• Incorporation of blended learning in future curriculum development	14%, n=2		

Figure 1.

Recurrent themes in the context of the SWOT paradigm. The frequency of recurring themes was calculated based on respondent survey data (a total of 14 responses from the 27 contacted medical schools in the United Kingdom and Republic of Ireland). The authors subsequently assigned these themes to the most appropriate heading of the SWOT paradigm.

result in students adopting different strategic approaches to their learning (Smith et al., 2014). Thus, it is imperative to ensure that these new resources are based upon sound pedagogical theory in order to foster deep learning strategies (Kreber, 2002). In addition, the number of new resources has the potential to overwhelm the learner, having negative implications for their extraneous cognitive load. Extraneous cognitive load is affected by how information is presented by the instructor (Leppink and van den Heuvel, 2015).

Upskilling in new technologies and resources. Three institutions (21%) noted that this is an opportunity to develop technological skills. One academic stated this was a “chance to upskill and incorporate alternative software and novel resources into our teaching.” This sudden leap in upskilling and innovation by a large proportion of academics has the potential to transform medical education by incorporating online learning to all aspects of the curricula (Skochelak and Stack, 2017; Rose, 2020). One academic stated that that this was an “opportunity to improve staff awareness of online teaching methods and their confidence in using them.” For anatomists, this is a unique opportunity to assess the educational benefits of this software, encouraged by free licenses offered by many companies during this time, such as “Visible Body” (Argosy Publishing, Inc., Newton, MA) and “Human Biodigital” (Biodigital Inc., Seoul, South Korea).

Furthermore, it has triggered the development of new skills in assessment modalities. As all universities have adopted an online approach to written examinations, new skills in utilizing the full capabilities of Virtual Learning Environments are being explored. Virtual Learning Environments allow academics to easily build question banks and design assessments that can be marked automatically or manually. Virtual Learning Environments also facilitate randomized presentation of questions, time constraints, and prohibit backtracking in order to prevent collaborative answering. For example, “Brightspace” (D2L Corp., Kitchener, Canada) facilitates precise keystroke recording—an important feature to prevent cheating during online spotters. The move to online assessment has identified an opportunity to improve examination conditions (Dennick

et al., 2009). Specifically, this is true for summative continuous assessments that often involve image-based spotter examinations as there is a high workload associated with designing and implementing station-based spotter exams. Schubert et al., (2009) reported that designing, implementing, and invigilating a station-based gross anatomy examination encompassed 3.5 days’ work (Shubert et al., 2009). Dennick et al., (2009) showed that student performance on gross anatomical examination is no different between traditional spotter examinations compared to digital online modes. The development of skills in online assessment modalities may be of benefit for future academic practice without endangering academic integrity or student performance (Meyer et al., 2016).

Weaknesses

Time constraints. Time is ultimately of the essence when it comes to creating additional anatomical resources in response to Covid-19, with universities identifying it as the top challenge in the delivery of anatomical education. One academic noted that the “time needed to learn how to use technologies” was an issue. Creating new resources can take at least three times as much work compared to a traditional format (Gewin, 2020). This may be attributed to the steep learning curve required to learn how to use technologies effectively. The added pressure of producing “high-quality resources,” in addition to fulfilling other academic duties in a limited time period may put undue pressure on academics. Therefore, it is imperative to weigh-up the cost–benefit implications of the time needed to create new resources against the educational benefit for the students. Indeed, it was observed that instructor-made videos lead to no measurable improvements in student achievement (Mandernach, 2009); however, it may have an impact in student engagement as discussed in the section outlining potential threats. Furthermore, well-renowned anatomical educational resources already exist, so one must decide if it is worth ‘re-inventing the wheel’, so to speak. For example, “Acland’s Video Atlas of Human Anatomy” (Acland, 2013),

created in 1993, is still used by medical schools today along with other useful online resources as outlined by participating universities (Table 2).

Lack of practical sessions and cadaveric exposure. The results show that a major concern for academics is the loss of cadaveric-based teaching, as expressed by 50% of participating universities. Cadavers are utilized as the pillar pedagogical tool in many medical schools across the globe (Habicht et al., 2018). Indeed, one academic stated that “not physically attending practical sessions will limit haptic understanding and reduce discussions concerning variations and pathology.” The benefits of cadaveric-based teaching have been eluded in a number of studies (Aziz et al., 2002; Estai and Bunt, 2016). Cadaveric-based teaching has been shown to lead to a deep understanding of the three-dimensional relationships of the human body and allows students to appreciate anatomical variations and pathologies (Azer and Eizenberg, 2007; Smith and Mathaias, 2010; Fruhstorfer et al., 2011; Hafferty and O'Donnell, 2013). Cadaveric dissection can be a sensory explosion, arguably one that cannot be stimulated by technology (Korf et al., 2008). In addition, it allows students to develop competencies of medical profession and gain attributes through the hidden anatomical curriculum, for example, encountering death, empathy, and professionalism, in addition to communication and teamwork skills (Estai and Bunt, 2016; Kumar Ghosh and Kumar, 2019). Additionally, students themselves believe that working with cadaveric material helps them learn anatomy and is an important component of becoming a healthcare professional (Smith et al., 2014; Flack and Nicholson, 2018).

In the UK and ROI, fortunately the lockdown occurred nearer the end of the academic term, thus students will have been exposed to cadaveric material for approximately six or seventh months. Conversely, this is not the case for other countries, e.g., in Australia and New Zealand, where the academic term begins in February/March. All medical students may be disproportionately affected by the lack of cadaveric-based classes. Although further studies will elucidate how the current Covid-19 crisis will affect students' understanding of anatomy, a previous report revealed that students participating in gross anatomy laboratories received significantly higher grades, compared to those taking an online course (Mathiowetz et al., 2016).

With many institutions looking to produce new online content to replace cadaveric dissection the HTA have released a new statement regarding the use of cadaveric images, reiterating the importance of protecting the dignity of the deceased (HTA, 2020a). Where cadaveric images are to be used to supplement online teaching, it is imperative to check if the donor provided consent for their remains to be used in images and videos. (HTA, 2016; Hennessy et al., 2020). Some institutions have also put in measures to limit sharing of cadaveric material now available on Virtual Learning Environments by ensuring students are able to view but not download this content.

Issues with assessment. Twenty-nine percent of the institutions surveyed did not have pre-existing summative assessments based on practical content. Of those that did, 36% canceled the summative element, and 21% switched to online assessments to maintain normal student progression (Table 3). However, online assessments pose their own unique challenges. One key principle that needs to be considered is the preservation of constructive alignment of the assessment task to the intended learning outcomes and teaching/learning activities (Biggs and Tang, 2011). Many higher education institutions teach through cadaveric dissection and assess the practical element of learnings through a traditional spotter

style format. This will encourage students to construct their knowledge of anatomy through learning activities with a focus on cadaveric material. However, online assessments cannot replicate the wealth of information available in a cadaveric specimen that can act as a retrieval cue for learning that took place during practical classes (Ali et al., 2015).

A switch to online assessment could cause a breakdown of constructive alignment between the teaching learning activity and assessment task. The results highlighted that 14% of universities identified compromised assessment standards as a significant concern, with “questions around validity and practicality of delivering exams online.” One way of mitigating this would be to ensure that images used in online assessments reflect those used during teaching and learning activities. Research has suggested that assessment modality does not significantly influence student achievement (Attardi and Rogers, 2015) and highlights the need for carefully chosen images with clear orientation (Meyer et al., 2016). In order to maintain constructive alignment, it is important that new assessment modalities are chosen that best assess the skills students are expected to achieve through their learning.

Opportunities

Academic collaboration and working remotely. The Covid-19 pandemic presented opportunities for online collaboration between academic peers, both within and between institutions to gain “insight and inspiration” from others that “are facing similar challenges.” These were ranked as the main opportunities by 50% of the universities in this study. Additionally, four institutes commented on the opportunity to create new and effective online working environments which particularly highlights the opportunity for remote working in the future. While there were two responses regarding the negative aspects of working from home, they both reflected the impact of the current Covid-19 crisis (i.e., lack of textbooks and childcare responsibilities). Already, there has been a wealth of support and resources offered by numerous academics on Twitter^(TM) (Twitter Inc., San Francisco, CA), Facebook^(TM) (Facebook Inc., Menlo Park, CA), and other social media platforms. In addition, the Anatomical Society has a collaborative database containing online resources (AS, 2020). An online network, particularly in circumstances such as these can have an impact on academic success (Maican et al., 2019). External collaborations can act as a source of support and are particularly important in institutions with small teams of anatomists. Nurturing these collaborations and developing an online community of practice in the future is a huge opportunity for the anatomical community. This is especially important for the next academic year as the impact of Covid-19 on the body donor program and anatomical education is yet to be fully appreciated. Additionally, as many anatomy departments are developing new technological skills in teleconferencing, there is a potential to pool expertise among institutions. It gives departments the opportunity to have “online connections made between peers,” to share expertise in anatomical sub-specialties and to showcase cutting-edge anatomical research across satellite campuses, and indeed across institutions worldwide.

Incorporation of blended learning in future curriculum development. Academics reported being excited at the chance to develop new resources as it was the most frequently

cited opportunity among the cohort (71% of responders). The decline in the priority of cadavers, and indeed anatomy as a subject, within medical curricula is well documented (Drake et al., 2002; Drake et al., 2009). With diminished resources including curricula time, budgets, and staffing, in conjunction with increased student numbers, innovative and novel approaches are needed to solve these pressing issues. Perhaps Covid-19 could act as a catalyst to do so. Fourteen percent of academics suggested that this crisis presented them with an opportunity to develop resources that can be used in the upcoming academic year, allowing them to incorporate more blended learning techniques and review the curriculum. Therefore, it is imperative that enough time can be dedicated in order to create high-quality references.

Threats

Reduced student engagement. A frequently expressed concern was diminished student engagement as a function of the rapid implementation of distance learning (36% of responders). On consideration, this may be compounded by the fact that many universities are no longer pursuing typical mandatory attendance policies for teaching sessions. Moreover, the current Covid-19 crisis may cause an increased risk of isolation, anxiety, and boredom among the population (Rubin and Wessely, 2020). This was also highlighted by one institution as a major concern among the student population where they were worried about the levels of “anxiety” that students face on “the future of their education.” Previous studies have shown a decrease in quality of life and stress negatively impacts student motivation and academic results (Artino et al., 2010; Lyndon et al., 2017). Specifically, the responses from this study included comments that highlighted their concerns with “creating resources that students will actively engage with” as well as how to “encourage and maintain student engagement.” Thus, academics adapting their approach to anatomical education should consider the need for support, interactivity, and social engagement with and between the students. A reduction in these elements may ultimately impede academic progress and student satisfaction. Ultimately, one academic expressed they wanted to ensure that students “were getting value for money” from their course. Additionally, technical issues, for example, unstable internet connections or lack of suitable electronic devices, will also impact student engagement (Wimpenny and Savin-Baden, 2013; Ilgaz and Gülbahar, 2015). The unexpected shift to distance learning means that some students may not be technically prepared for distant learning and assessment. Therefore, due consideration to accessibility must also be considered as a potential threat to delivery of distance learning and assessment. In conjunction with potential issues in relation to the student population, staff may not have proficient knowledge of pedagogical techniques specific to the delivery of online teaching. Some staff members may not have been able to fully evaluate the theoretical and practical implications of distance learning prior to the cessation of face-to-face teaching. This may also impact on their ability to boost student engagement (Wimpenny and Savin-Baden, 2013).

Teacher–student relationship. Maintaining the teacher–student relationship was considered a threat (21% of responders) as online resources lead to a perceived improvement in the online instructor social presence (Draus et al., 2014). The online instructor presence effectively reduces the transactional distance between student and instructor (Attardi et al.,

2018; Stone and Barry, 2019) by increasing the likelihood of interaction. One way to address this issue is to host synchronous (live) classes (McBrien et al., 2009; O’Flaherty and Laws, 2014). This approach was taken by 36% of universities that hosted live lectures and 43% hosted live tutorials to support practical sessions. Many synchronous software packages contain interactive polls that can be used to assess knowledge, encourage engagement, and provide instant feedback to students. Studies have shown that timely feedback from instructors is hugely important in maintaining engagement (Martin and Bolliger, 2018; Ragusa and Crampton, 2018). Interactive polling can therefore be utilized in a flipped-classroom approach, shown to increase student interactivity as all levels of Bloom’s taxonomy can be assessed if correctly designed (Gilroy et al., 2015). Providing clear guided instructions for problem solving and linking content to clinical practice and prior knowledge are other methods that are proven to improve engagement (Wimpenny and Savin-Baden, 2013; Botton and Gregory, 2015; Ilgaz and Gülbahar, 2015; Buelow et al., 2018; Martin and Bolliger, 2018). Thus, within the synchronous classes, staff can potentially utilize anatomical education software programs to incorporate applied anatomy and clinical scenarios into their sessions. In this regard, there is evidence that virtual synchronous conferencing methods may increase peer–peer and peer–teacher interactions (McBrien et al., 2009; O’Flaherty and Laws, 2014).

However, in the Covid-19 crisis, synchronous teaching may be deemed unsuitable for a proportion of the student population. Students living in different time zones or those with parental and caregiving responsibilities may be unable to attend scheduled synchronous sessions. As synchronous sessions offer potential for interactivity, students unable to attend may feel particularly isolated if departments solely relied on synchronous teaching methods. To address this, interactive asynchronous teaching methods have been employed, for example, Twitter^(TM) and discussion boards or Padlet^(TM) (Padlet, Inc., San Francisco, CA) (Table 1). A strong teacher–student relationship results in students feeling more comfortable engaging with online communication platforms such as discussion boards (Griffiths and Graham, 2009; Rose, 2009). The use of social media has been shown to diminish anxiety and foster a sense of community (Hennessy et al., 2016). However, if these options are unavailable, adapting resources that are already used across ten institutions in our study can include interactive elements within asynchronous teaching. This includes creating a short video content of problem-solving tasks with recorded audiovisual input from the tutor. Such an approach permits students to consistently see and hear their tutor, with the potential to aid in student engagement (Wimpenny and Savin-Baden, 2013; Botton and Gregory, 2015; Ilgaz and Gülbahar, 2015; Buelow et al., 2018; Martin and Bolliger, 2018).

Limitation of the Study

It is also important to consider the limitations of the methodologies employed and the data presented. First, the presented data are representative of a subset of the total number of medical schools in the UK and ROI. It is conceivable that adaptations utilized by an individual institution or minority of universities may have been missed due to inadequate sampling. Second, during the data collection process only a single individual was contacted from each institution. It is our presumption that respondents’ answers accurately reflect the most commonly

utilized adaptations at their respective institutions—though our methodology did not establish this. Third, the authors did not sample any universities in Scotland. This is important to consider as differing national practices could affect the various adaptations utilized by universities in response to the pandemic. Fourth, our survey sought to establish information pertaining to the education of medical students only and did not consider the allied health disciplines. It would be interesting to also identify the adaptations utilized by universities to manage this cohort's education as any niche solution employed could also be translated to the medical cohort. Fifth, the survey did not explicitly state that respondents should describe the strengths and weaknesses of the various adaptations implemented by their respective university. The authors believed that incomplete responses would be returned if respondents were required to provide more information. In hindsight, the utility of these adaptations would have been better contextualized if the authors had formally sought for respondents to comment on the strengths and weaknesses of the adaptations implemented at their university. Sixth, due to the small sample size, statistics for interval validity were not possible.

CONCLUSION

Everyone is currently amid an unprecedented global event. The effects of Covid-19 upon anatomical education, and medical education, are not yet fully understood. Changes to curriculum normally take years to research, enforce, and evaluate. However, the current crisis has forced academics to make radical adjustments in a short period of time. The SWOT analysis and embedded pedagogical theory of these changes has been presented in the hope that anatomists feel more confident in their decision-making. Additionally, as the change in anatomical education has been so sudden over the course of the next few months, academics' responses may change and new threats and opportunities may arise. Currently, negative effects, such as the time pressure, changes to assessment, and implications in students' engagements and relationship, are somewhat balanced by, positive consequences, such as the potential to create new resources and foster academic collaborations, also arise. Indeed, this crisis may be a catalyst for the integration of novel technological resources and the development of stronger ties and collaborations between anatomy departments. It is evident that anatomy departments across the UK and ROI are putting tremendous effort into the delivery of high-quality education in the midst of the pandemic. It is hoped that the adaptations utilized by universities will ultimately translate to a lasting positive change in the delivery of anatomical education; and as such there are plans to assess the sustainability of these modalities with a follow-up survey.

ACKNOWLEDGMENT

The authors would like to express their sincerest gratitude to the fellow anatomists who contributed to this study. It is our hope that this crisis leads to the beginning of many new collaborations.

NOTES ON CONTRIBUTORS

GEORGA J. LONGHURST, B.Sc., M.Sc. S.P. Cert., is a lecturer in anatomical sciences at St George's University of London in London, UK. She teaches anatomy to medical and allied health students. She has a research interest in anatomical education.

DANYA M. STONE, B.Sc., M.Sc., F.H.E.A., is a lecturer in anatomy Brighton and Sussex Medical School (Brighton), Falmer, UK. She teaches anatomy to medical students and contributes to teaching on multiple external courses. Her research interest is in medical education.

KATE DULOHERY, B.Sc., M.Sc., Ph.D., F.H.E.A., is a lecturer in anatomy in School of Medical Education at Newcastle University, Newcastle upon Tyne, UK. She teaches anatomy to medical, dentistry and allied health students and her research interests include incorporation of technology in anatomical education.

DEIDRE SCULLY, B.Sc., M.Sc., Ph.D., is a teaching fellow in the Department of Anatomy, School of Medicine at Trinity College Dublin, The University of Dublin, Dublin, Republic of Ireland. She teaches medical and allied health students and her research interests include reproductive biology and anatomical education.

THOMAS CAMPBELL, B.A., M.B., B.Ch., B.A.O., M.Sc., Ph.D., is a lecturer in human anatomy at School of Medicine, University College Dublin, Belfield, Dublin, Republic of Ireland. He teaches both allied health and medical students, and his research interests include neuroscience, 3D printing, and education.

CLAIRE F. SMITH, B.Sc., P.G.C.E., Ph.D., S.F.H.E.A., F.A.S., F.L.F., N.T.F., is a professor and Head of Anatomy at Brighton and Sussex Medical School (Brighton), Falmer, UK. She is a fellow of the Anatomical Society, a member of the Court of Examiners for the Royal College of Surgeons England. She teaches all areas of gross anatomy and her research is in understanding the learning experience.

LITERATURE CITED

- Acland R. 2013. Acland's Video Atlas of Human Anatomy®. Wolters Kluwer Health, Inc., Philadelphia, PA. URL: <https://aclandanatomy.com/> [accessed 10 April 2020].
- Ahmed H, Allaf M, Elghazaly H. 2020. COVID-19 and medical education. *Lancet Inf Dis* (in press; [https://doi.org/10.1016/S1473-3099\(20\)30226-7](https://doi.org/10.1016/S1473-3099(20)30226-7)).
- Ali A, Khan ZN, Konczalik W, Coughlin P, El Sayeds S. 2015. The perception of anatomy teaching among UK medical students. *Bull Roy Coll Surg Engl* 97:397–400.
- Artino AR, La Rochelle JS, Durning SJ. 2010. Second-year medical students' motivational beliefs, emotions, and achievement. *Med Educ* 44:1203–1212.
- AS. 2020. Anatomical Society. Online Resources. Anatomical Society, London, UK. URL: <http://anatsoc.org.uk/education/digital-education-and-resources/resources> [accessed 10 April 2020].
- Attardi SM, Barbeau ML, Rogers KA. 2018. Improving online interactions. Lessons from an online anatomy course with a laboratory for undergraduate students. *Anat Sci Educ* 11:592–604.
- Attardi SM, Rogers KA. 2015. Design and implementation of an online systemic human anatomy course with laboratory. *Anat Sci Educ* 8:53–62.
- Ayittey FK, Ayittey MK, Chiwero NB, Kamasah JS, Dzuvoor C. 2020. Economic impacts of Wuhan 2019-nCoV on China and the world. *J Med Virol* 92:473–475.
- Azer SA, Eizenberg N. 2007. Do we need dissection in an integrated problem-based learning medical course? Perceptions of first- and second-year students. *Surg Radiol Anat* 29:173–180.
- Aziz MA, McKenzie JC, Wilson JS, Cowie RJ, Ayeni SA, Dunn BK. 2002. The human cadaver in the age of biomedical informatics. *Anat Rec* 269:20–32.
- Buelow JR, Barry T, Rich LE. 2018. Supporting learning engagement with online students. *Online Learn* 22:313–340.
- Burr S. 2009. Integrating assessment innovations in medical education. *Br J Hosp Med* 70:162–163.
- Biggs JB, Tang C. 2011. *Teaching for Quality Learning at University*. 4th Ed. Maidenhead, UK: Open University Press, Inc. 480 p.
- Billings DM. 2007. Distance education in nursing: 25 years and going strong. *Comput Inform Nurs* 25:121–123.
- Boton EC, Gregory S. 2015. Minimizing attrition in online degree courses. *J Educ Online* 12:62–90.
- Braun V, Clarke V. 2012. Thematic analysis. In: Cooper H, Camic PM, Long DL, Panter AT, Rindskopf D, Sher KJ (Editors). *APA Handbook of Research Methods in Psychology*. Volume 2. Research Designs: Quantitative, Qualitative,

- Neuropsychological, and Biological. 1st Ed. Washington, DC: American Psychological Association. p 57–71.
- Darras KE, Spounge R, Hatala R, Nicolaou S, Hu J, Worthington A, Krebs C, Forster BB. 2019. Integrated virtual and cadaveric dissection laboratories enhance first year medical students' anatomy experience: A pilot study. *BMC Med Educ* 19:366.
- Dennick R, Wilkinson S, Purcell N. 2009. Online eAssessment: AMEE guide no. 39. *Med Teach* 31:192–206.
- DES. 2020. Department of Education and Skills. Briefing on Covid-19 Responses in Education and Training Sector. 1st Ed. Dublin, Republic of Ireland: Government of Ireland. 26 p. URL: <https://www.education.ie/en/The-Department/Announcements/briefing-on-covid-19-responses-in-the-education-and-training-sector.pdf> [accessed 12 April 2020].
- DH&DT. 2020. Department of Health and Department of the Taoiseach. Public health measures in place until 5 May to prevent spreading COVID-19. Government of Ireland, Dublin, Republic of Ireland. URL: <https://www.gov.ie/en/publication/cf9b0d-new-public-health-measures-effective-now-to-prevent-further-spread-of/> [accessed 10 April 2020].
- DiLullo C, Coughlin P, D'Angelo M, McGuinness M, Bandle J, Slotkin EM, Shainker SA, Wenger C, Berray SJ. 2006. Anatomy in a new curriculum: Facilitating the learning of gross anatomy using web access streaming dissection videos. *J Vis Commun Med* 29:99–108.
- Drake RL, Lowrie DJ Jr, Prewitt CM. 2002. Survey of gross anatomy, microscopic anatomy, neuroscience, and embryology courses in medical school curricula in the United States. *Anat Rec* 269:118–122.
- Drake RL, McBride JM, Lachman N, Pawlina W. 2009. Medical education in the anatomical sciences: The winds of change continue to blow. *Anat Sci Educ* 2:253–259.
- Draus PJ, Curran MJ, Trempus MS. 2014. The influence of instructor generated video content on students satisfaction with and engagement in asynchronous online courses. *J Online Learn Teach* 10:240–254.
- Estai M, Bunt S. 2016. Best teaching practices in anatomy education: A critical review. *Ann Anat* 208:151–157.
- Ferrer-Torregrosa J, Jiménez-Rodríguez MÁ, Torralba-Estelles J, Garzón-Farínós F, Pérez-Bermejo M, Fernández-Ehrlich N. 2016. Distance learning ects and flipped classroom in the anatomy learning: Comparative study of the use of augmented reality, video and notes. *BMC Med Educ* 16:230.
- Finegan O, Fonseca S, Guyomarc'h P, Mendez MDM, Gonzalez JR, Tidball-Binz M, Winter KA, ICR Advisory Group on the Management of COVID-19 Related Fatalities. 2020. International Committee of the Red Cross (ICRC): General guidance for the management of the dead related to Covid-19. *Forensic Sci Int Synergy* 2:129–137.
- Flack NA, Nicholson HD. 2018. What do medical students learn from dissection? *Anat Sci Educ* 11:325–335.
- Fruhstorfer BH, Palmer J, Brydges S, Abrahams PH. 2011. The use of plastinated preparations for teaching anatomy—the view of medical students on the value of this learning resource. *Clin Anat* 24:246–252.
- Gewin V. 2020. Five tips for moving teaching online as COVID-19 takes hold. *Nature* 580:295–296.
- Gilroy MB, Heinerichs S, Pazzaglia G. 2015. Enhancing Student Engagement Using the Flipped Classroom. *J Nutr Educ Behav* 47:109–114.
- Glaser BG, Strauss AL. 1967. *Discovery of Grounded Theory: Strategies for Qualitative Research*. 1st Ed. New Brunswick, NJ: Aldine Transactions. 282 p.
- GMC. 2017. General Medical Council United Kingdom. Our data on medical students and doctors in training in the UK. In: GMC. *The State of Medical Education and Practice in the UK*. 2017 Ed. London, UK: General Medical Council United Kingdom. p 57–72. URL: https://www.gmc-uk.org/static/documents/content/SoMEP_2017_chapter_2.pdf [accessed 10 April 2020].
- GOV.UK. 2020a. Government of United Kingdom. Coronavirus (COVID-19): Guidance for educational settings. Department of Education, Public Health England, London, UK. URL: <https://www.gov.uk/government/publications/guidance-to-educational-settings-about-covid-19/guidance-to-educational-settings-about-covid-19> [accessed 12 April 2020].
- GOV.UK. 2020b. Coronavirus (COVID-19): Guidance for isolation for residential educational settings. Department of Education, Public Health England, London, UK. URL: <https://www.gov.uk/government/publications/coronavirus-covid-19-guidance-on-isolation-for-residential-educational-settings/coronavirus-covid-19-guidance-on-isolation-for-residential-educational-settings> [accessed 12 April 2020].
- Green RA, Whitburn LY. 2016. Impact of introduction of blended learning in gross anatomy on student outcomes. *Anat Sci Educ* 9:422–430.
- Griffiths ME, Graham CR. 2009. The potential of asynchronous video in online education. *Dist Learn* 6:13–22.
- Hafferty FW, O'Donnell JF (Editors). 2013. *The Hidden Curriculum in Health Professional Education*. 1st Ed. Hanover, NH: Dartmouth College Press. 320 p.
- Habicht JL, Kiessling C, Winkelmann A. 2018. Bodies for anatomy education in medical schools: An overview of the sources of cadavers worldwide. *Acad Med* 93:1293–1300.
- Hazzan O, Heyd-Metzuyanim E, Even-Zahav A, Tal T, Dori YJ. 2018. STEM Teachers' SWOT analysis of STEM education: The bureaucratic–professional Conflict. In: Hazzan O, Heyd-Metzuyanim E, Even-Zahav A, Tal T, Dori YJ. *Application of Management Theories for STEM Education: The Case of SWOT Analysis*. 1st Ed. Cham, Switzerland: Springer International Publishing AG. p 1–23.
- Heffron M, Socha-Dietrich K. 2019. The Irish paradox: Doctor shortages despite high numbers of domestic and foreign medical graduates. In: OECD. *Recent Trends in International Migration of Doctors, Nurses and Medical Students*. 1st Ed. Paris, France: Organization for Economic Co-operation and Development Publishing. p 67–87.
- Helms MM, Nixon J. 2010. Exploring SWOT analysis—Where are we now? A review of academic research from the last decade. *J Strateg Manag* 3:215–251.
- Hennessy CM, Kirkpatrick E, Smith CF, Border S. 2016. Social media and anatomy education: Using Twitter to enhance the student learning experience in anatomy. *Anat Sci Educ* 9:505–515.
- Hennessy CM, Royer DF, Meyer AJ, Smith CF. 2020. Social media guidelines for anatomists. *Anat Sci Educ* (in press; <https://doi.org/10.1002/ase.1948>).
- Heylings DJ. 2002. Anatomy 1999–2000: The curriculum, who teaches it and how? *Med Educ* 36:702–710.
- Holmes F. 2020. 08 Apr COVID-19 Timeline. The British Foreign Policy Group (BFPG), London, UK. URL: <https://bfpbg.co.uk/2020/04/covid-19-timeline/> [accessed 10 April 2020].
- HPSC. 2020. Health Protection Surveillance Centre. COVID-19 Health Surveillance Monitor. Health Protection Surveillance Centre, Dublin, Republic of Ireland. URL: <https://www.hpsc.ie/az/respiratory/coronavirus/novelcoronavirus/casesinireland/> [accessed 10 April 2020].
- HTA. 2016. Human Tissue Authority. HTA Guidelines: Filming or Photographing of Bodies or Body Parts That Have Been Donated to Medical Schools or Surgical Training Centres. 1st Ed. London, UK: Human Tissue Authority. 3 p. URL: <https://www.hta.gov.uk/sites/default/files/HTA%20%20Filming%20Guidelines%20-%20Body%20Donation%20%28v1.1%29.pdf> [accessed 10 April 2020].
- HTA. 2020a. Human Tissue Authority. Anatomy sector guidance. Human Tissue Authority, London, UK. URL: <https://www.hta.gov.uk/anatomy-sector-guidance> [accessed 10 April 2020].
- HTA. 2020b. Human Tissue Authority. Guidance on HTA licensing of emergency mortuaries. 2020 Ed. London, UK: Human Tissue Authority. URL: <https://www.hta.gov.uk/sites/default/files/HTA-GD-034%20External%20-%20Guidance%20on%20HTA%20licensing%20of%20emergency%20mortuaries.pdf> [accessed 10 April 2020].
- Ilgaz H, Gülbahar Y. 2015. A snapshot of online learners: E-Readiness, e-satisfaction and expectations. *Int Rev Res Open Distr Learn* 16:171–187.
- Korf HW, Wicht H, Snipes RL, Timmermans JP, Paulsen F, Rune G, Baumgart-Vogt E. 2008. The dissection course—Necessary and indispensable for teaching anatomy to medical students. *Ann Anat* 90:16–22.
- Kumar Ghosh S, Kumar A. 2019. Building professionalism in human dissection room as a component of hidden curriculum delivery: A systematic review of good practices. *Anat Sci Educ* 12:210–221.
- Kreber C. 2002. Teaching excellence, teaching expertise and the scholarship of teaching. *Innovat High Educ* 27:5–23.
- Leiber T, Stensaker B, Harvey LC. 2018. Bridging theory and practice of impact evaluation of quality management in higher education institutions: A SWOT analysis. *Eur J High Educ* 8:351–365.
- Leppink J, van den Heuvel A. 2015. The evolution of cognitive load theory and its application to medical education. *Perspect Med Educ* 4:119–127.
- Liu H. 2017. SWOT analysis of the current nursing education in China. *Int J Nurs Sci* 4:345.
- Lyndon MP, Henning MA, Alyami H, Krishna S, Zeng I, Yu TC, Hill AG. 2017. Burnout, quality of life, motivation, and academic achievement among medical students: A person-oriented approach. *Perspect Med Educ* 6:108–114.
- Mahase E. 2020. Covid-19: UK starts social distancing after new model points to 260 000 potential deaths. *BMJ* 368:m1089.
- Maican CI, Cazan AM, Lixandriou RC, Dovleac L. 2019. A study on academic staff personality and technology acceptance: The case of communication and collaboration applications. *Comput Educ* 128:113–131.
- Mandernach BJ. 2009. Effect of instructor-personalized multimedia in the online classroom. *Int Rev Res Open Distr Learn* 10:605.
- Martin F, Bolliger DU. 2018. Engagement matters: Student perceptions on the importance of engagement strategies in the online learning environment. *Online Learn* 22:205–222.
- Mathiowets V, Yu CH, Quake-Rapp C. 2016. Comparison of a gross anatomy laboratory to online anatomy software for teaching anatomy. *Anat Sci Educ* 9:52–59.
- McBrien JL, Cheng R, Jones P. 2009. Virtual spaces: Employing a synchronous online classroom to facilitate student engagement in online learning. *Int Rev Res Open Distr Learn* 10:3.
- McNulty JA, Espiritu B, Halsey M, Mendez M. 2006. Personality preference influences medical student use of specific computer-aided instruction (CAI). *BMC Med Educ* 6:7.
- Meng L, Hua F, Bian Z. 2020. Coronavirus disease 2019 (COVID-19): Emerging and future challenges for dental and oral medicine. *J Dent Res* 99:481–487.
- Meyer AJ, Innes SJ, Stomski NJ, Armson AJ. 2016. Student performance on practical gross anatomy examinations is not affected by assessment modality. *Anat Sci Educ* 9:111–120.
- Mian A, Khan S. 2020. Medical education during pandemics: A UK perspective. *BMC Med* 18:100.

- Moszkowicz D, Duboc H, Dubertret C, Roux D, Bretagnol F. 2020. Daily medical education for confined students during COVID-19 pandemic: A simple videoconference solution. *Clin Anat* (in press; <https://doi.org/10.1002/ca.23601>).
- MSC. 2020. Medical Schools Council. Advice from Medical Schools Council to UK Medical Schools on Actions Surrounding Covid-19. 1st Ed. London, UK: The Medical Schools Council. 3 p. URL: <https://www.medschools.ac.uk/media/2620/msc-covid-19-advice-for-uk-medical-schools.pdf> [accessed 12 April 2020].
- O'Flaherty JA, Laws TA. 2014. Nursing student's evaluation of a virtual classroom experience in support of their learning bioscience. *Nurse Educ Pract* 14:654–659.
- Patil NG, Yan YC. 2003. SARS and its effect on medical education in Hong Kong. *Med Educ* 37:1127–1128.
- Pereira JA, Meri A, Masdeu C, Molina-Tomás MC, Martínez-Carrió A. 2004. Using videoclips to improve theoretical anatomy teaching. *Eur J Anat* 8:134–146.
- Pereira JA, Pleguezuelos E, Meri A, Molina-Ros A, Molina-Tomás MC, Masdeu C. 2007. Effectiveness of using blended learning strategies for teaching and learning human anatomy. *Med Educ* 41:189–195.
- PHE. 2020. Public Health England. Guidance: Staying at home and away from others (social distancing). London, UK. URL: <https://www.gov.uk/government/publications/full-guidance-on-staying-at-home-and-away-from-others/full-guidance-on-staying-at-home-and-away-from-others> [accessed 10 April 2020].
- Ragusa AT, Crampton A. 2018. Sense of connection, identity and academic success in distance education: Sociologically exploring online learning environments. *Rural Soc* 27:125–142.
- Rose KK. 2009. Student perceptions of the use of instructor-made videos in online and face-to-face classes. *J Online Learn Teach* 5:487–495.
- Rose S. 2020. Medical student education in the time of COVID-19. *JAMA* (in press; <https://doi.org/10.1001/jama.2020.5227>).
- RTÉ. 2020. Raidió Teilifís Éireann. Coronavirus in Ireland – A timeline. Raidió Teilifís Éireann (RTÉ) Ireland's National Public Service Broadcaster, Donnybrook, Ireland. URL: <https://www.rte.ie/news/2020/0320/1124382-covid-19-ireland-timeline/> [accessed 10 April 2020].
- Rubin GJ, Wessely S. 2020. The psychological effects of quarantining a city. *BMJ* 368:m313.
- Schubert S, Schnabe K, Winkelmann A. 2009. Assessment of spatial anatomical knowledge with a 'three-dimensional multiple choice test' (3D-MC). *Med Teach* 31:e13–e17.
- Sharma M. 2005. Health education in India: A strengths, weaknesses, opportunities, and threats (SWOT) analysis. *Int Electron J Health Educ* 8:80–85.
- Shaw SC. 2020. Hopelessness, helplessness and resilience: The importance of safeguarding our trainees' mental wellbeing during the COVID-19 pandemic. *Nurse Educ Pract* 44:102780.
- Skochelak SE, Stack SJ. 2017. Creating the medical schools of the future. *Acad Med* 92:16–19.
- Smith CF, Mathaias HS. 2010. Medical students' approaches to learning anatomy: Students' experiences and relations to the learning environment. *Clin Anat* 23:106–114.
- Smith CF, Martínez-Álvarez C, McHanwell S. 2014. The context of learning anatomy: Does it make a difference? *J Anat* 224:270–278.
- Stone DM, Barry DS. 2019. Improving virtual learning interactions: Reducing the transactional distance of online anatomy modules. *Anat Sci Educ* 12:686–687.
- Teoli D, An J. 2019. SWOT Analysis. NCBI Internet Bookshelf. Treasure Island, FL: StatPearls Publishing. URL: <https://www.ncbi.nlm.nih.gov/pubmed/30725987> [accessed 10 April 2020].
- Topping DB. 2014. Gross anatomy videos: Student satisfaction, usage, and effect on student performance in a condensed curriculum. *Anat Sci Educ* 7:273–279.
- UNESCO. 2020. United Nations Educational, Scientific and Cultural Organization. COVID19 educational disruption and response. UNESCO, Paris, France. URL: <https://en.unesco.org/themes/education-emergencies/coronavirus-school-closures> [accessed 12 April 2020].
- Willan J, King A, Jeffery K, Bienz N. 2020. Challenges for NHS hospitals during Covid-19 epidemic. *BMJ* 368:m1117.
- Wimpenny K, Savin-Baden M. 2013. Alienation, agency and authenticity: A synthesis of the literature on student engagement. *Teach High Educ* 18:311–26.
- Wong JE, Leo YS, Tan CC. 2020. COVID-19 in Singapore—Current experience: Critical global issues that require attention and action. *JAMA* 323:1243–1244.
- WHO. 2020a. World Health Organization. Novel Coronavirus (2019-nCoV): Situation report – 1. 21 January 2020. 1st Ed. Geneva, Switzerland: World Health Organization. 5 p. URL: https://www.who.int/docs/default-source/coronavirus/situation-reports/20200121-sitrep-1-2019-ncov.pdf?sfvrsn=20a99c10_4 [accessed 11 April 2020].
- WHO. 2020b. World Health Organization. WHO Director-General's opening remarks at the media briefing on COVID-19 - 11 March 2020. World Health Organization, Geneva, Switzerland. URL: <https://www.who.int/dg/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020> [accessed 11 April 2020].
- Yamine K, Violato C. 2015. A meta-analysis of the educational effectiveness of three-dimensional visualization technologies in teaching anatomy. *Anat Sci Educ* 8:525–538.
- Zhu N, Zhang D, Wang W, Li X, Yang B, Song J, Zhao X, Hyang B, Shi W, Lu R, Niu P, Zhan F, Ma X, Wang D, Xu W, Wu G, Gao GF, Tan W, China Novel Coronavirus Investigating and Research Team. 2020. A novel coronavirus from patients with pneumonia in China. 2019. *N Engl J Med* 382:727–733.